

FHF05 series - heat flux sensors

Five models covering the most common heat flux measurement applications; new, patented technology, flexible, with temperature sensor

FHF05 is the product range to start your search if you consider measuring heat flux. Models are available in five different dimensions and sensitivities. All models from the FHF05 series are flexible, have an integrated temperature sensor and have thermal spreaders to reduce thermal conductivity dependence. Rated temperature range is from -70 to $+120$ °C. FHF05 sensors measure heat flux from conduction, radiation and convection. Optionally, black BLK and gold GLD stickers are available for all five models to separately determine heat transport by radiation and convection. In case the FHF05 series does not match your needs, have a look at our [heat flux sensor](#) models for special applications.

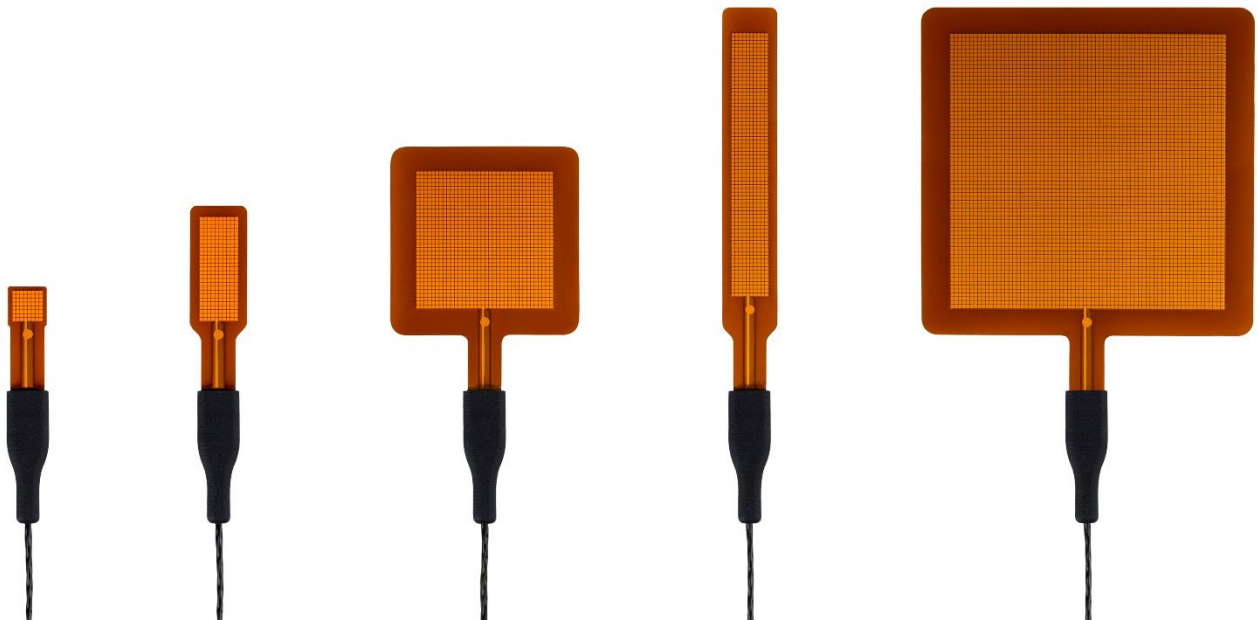


Figure 1 FHF05 series foil heat flux sensors with thermal spreaders: thin, flexible and versatile. Models are available in five different dimensions and sensitivities.

FHF05 series: covers most heat flux measurement applications

Sensors of the FHF05 series are suitable for general-purpose heat flux measurement. The range is available in five different dimensions. Larger dimensions mean a higher sensitivity and a larger area over which the heat flux is averaged.

They are thin, flexible and versatile. FHF05 series models measure heat flux through the object in which they are incorporated or on which they are mounted, in W/m^2 . The sensor in FHF05 is a thermopile. This thermopile measures the temperature difference across FHF05's flexible body. A type T thermocouple is integrated as well to provide a measurement of temperature. The thermopile and thermocouple are passive sensors; they do not require power.



Figure 2 FHF05-85X85 being installed to measure heat flux on a pipe.

Multiple small thermal spreaders, which form a conductive layer covering the sensor, help reduce the thermal conductivity dependence of the measurement. With its incorporated spreaders, the sensitivity of the FHF05 series is independent of its environment. Many competing sensors do not have thermal spreaders. The passive guard area around the sensor reduces measurement errors due to edge effects and is also used for mounting.

Using the FHF05 series is easy. It can be connected directly to commonly used data logging systems. The heat flux in W/m^2 is calculated by dividing the sensor output, a small voltage, by the sensitivity. The sensitivity is provided with the sensor on its certificate.

Unique features and benefits

- flexible (bending radius $\geq 7.5 \times 10^{-3}$ m)
- low thermal resistance
- wide temperature range
- fast response time
- large guard area
- integrated type T thermocouple
- robustness, including connection block, for strain relief
- IP protection class: IP67 (essential for outdoor application)
- integrated thermal spreaders for low thermal conductivity dependence

FHF05 series specifications

Measurand	heat flux
Measurand	temperature
Temperature sensor	type T thermocouple, IEC 60584-1:2013 class 2*
Thermal spreaders	included
Rated bending radius	$\geq 7.5 \times 10^{-3}$ m
Rated load on cable	≤ 1.6 kg
Outer dimensions (w x b)	$(10 \times 10) \times 10^{-3}$ m
foil with guard	$(15 \times 30) \times 10^{-3}$ m
	$(50 \times 50) \times 10^{-3}$ m
	$(15 \times 85) \times 10^{-3}$ m
	$(85 \times 85) \times 10^{-3}$ m
Sensor thermal resistance	11×10^{-4} K/(W/m^2)
Sensor thickness	0.4×10^{-3} m
Uncertainty of calibration	$\pm 5\%$ (k = 2)
Measurement range	$(-10$ to $10) \times 10^3$ W/m^2
Sensitivity (nominal) per model	
10X10:	1 $\times 10^{-6}$ V/(W/m^2)
15X30:	3 $\times 10^{-6}$ V/(W/m^2)
50X50:	13 $\times 10^{-6}$ V/(W/m^2)
15X85:	7 $\times 10^{-6}$ V/(W/m^2)
85X85:	50 $\times 10^{-6}$ V/(W/m^2)
Asymmetry	$< 2\%$
Rated operating temperature range	
continuous use:	-70 to +120 °C
short intervals:	-160 to +150 °C*
IP protection class	IP67***
Standard cable length	2 m
Options	5 or 10 m cable length separate cable without cable BLK black sticker GLD gold sticker

* temperature measurement uncertainty: 5 % of value in °C. For details, refer to user manual.

** when measuring at temperatures of -160 °C, contact Hukseflux.

*** sensor is not suitable for continuous exposure to water.



Figure 3 FHF05-15X85, thin and flexible, can be easily mounted on a curved surface like a pipe or tube.

Robust and stable

Equipped with a connection block, which may serve as strain relief, with potted protective covers on both sides which prevent moisture from penetrating, FHF05 has proven to be very robust and stable.

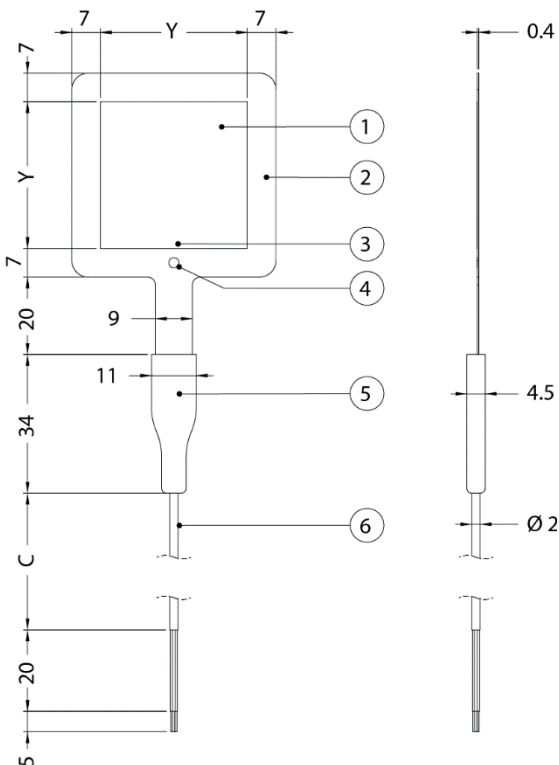


Figure 4 FHF05-10X10, -50X50 or -85X85 heat flux sensor: (1) sensing area with thermal spreaders, (2) passive guard, (3) type T thermocouple, (4) dot indicating front side, (5) connection block, (6) cable, standard length C is 2 m. The size of Y = 8, 36 or 70. All dimensions in $\times 10^{-3}$ m.

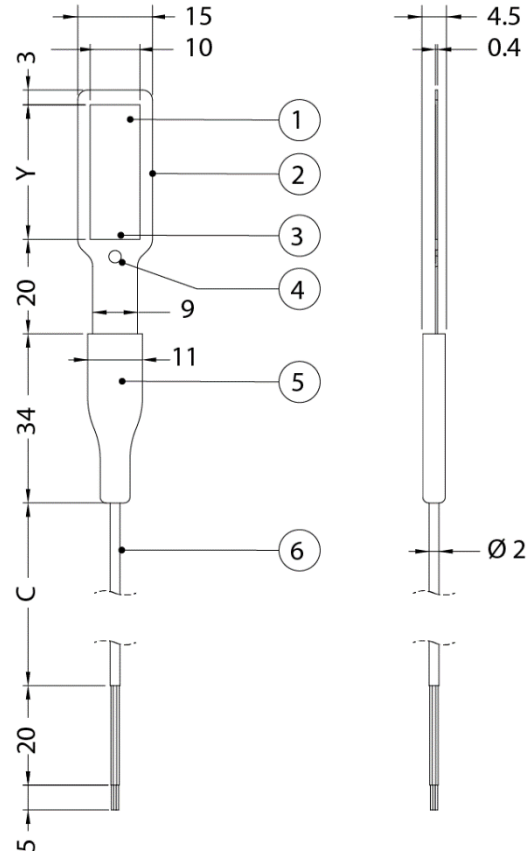


Figure 5 FHF05-15X30 or -15X85 heat flux sensor: (1) sensing area with thermal spreaders, (2) passive guard, (3) type T thermocouple, (4) dot indicating front side, (5) connection block, (6) cable, standard length is 2 m. The size of Y1 = 27 or 71. All dimensions in $\times 10^{-3}$ m.

BLK and GLD sticker series

Would you like to study energy transport / heat flux in detail? Hukseflux helps taking your measurement to the next level: order FHF05 with radiation-absorbing black and radiation-reflecting gold stickers. You can then measure convective + radiative flux with one, and convective flux only with the other. Subtract the 2 measurements and you have radiative flux. BLK – GLD stickers can be applied by the user to the sensor. There are stickers for every sensor dimension.

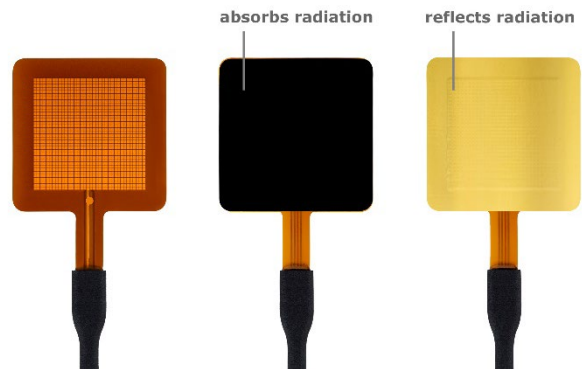


Figure 6 FHF05-50X50 with BLK-50X50 and GLD-50X50 stickers.

Optionally, they can be ordered pre-applied. See the BLK – GLD sticker series user manual and installation video for instructions.

Suggested use

FHF05 series can be used for general-purpose heat flux measurement, often applied as part of a larger test- or measuring system. **FHF05SC series** on the other hand, are self-calibrating versions of the standard FHF05 models, combined with a **HTR02 series** heater. FHF05SC series is used when the highest level of quality assurance is required and for long-term heat flux measurement. The self-calibrating sensor is available in models -50X50 and -85X85.

Typical applications per model

- 10X10: high power microchips
- 15X30: high heat flux in ovens
- 50X50: general purpose, battery thermal management
- 15X85: wrapped around a pipe
- 85X85: low heat fluxes, insulation performance testing, low accuracy dataloggers & amplifiers



Figure 7 Model FHF05-50X50 with BLK and GLD stickers for measuring insulation losses of a thermos.

Calibration

FHF05 calibration is traceable to international standards. The factory calibration method follows the recommended practice of ASTM C1130 - 21.

Working with heat flux sensors

When used under conditions that differ from the calibration reference conditions, the FHF05 sensitivity to heat flux may be different than stated on its certificate. See the user manual for suggested solutions. See also our application note [how to install a heat flux sensor](#).

Options

- with 5 or 10 metres cable length
- separate cable in 2, 5 or 10 metres length
- without wiring, without connection block
- **LI19** hand-held read-out unit / datalogger
NOTE: LI19 measures heat flux only
- BLK sticker for all models (to measure radiative as well as convective heat flux)
- GLD sticker for all models (to measure convective heat flux only)
- BLK - GLD sticker series can also be ordered pre-applied at the factory

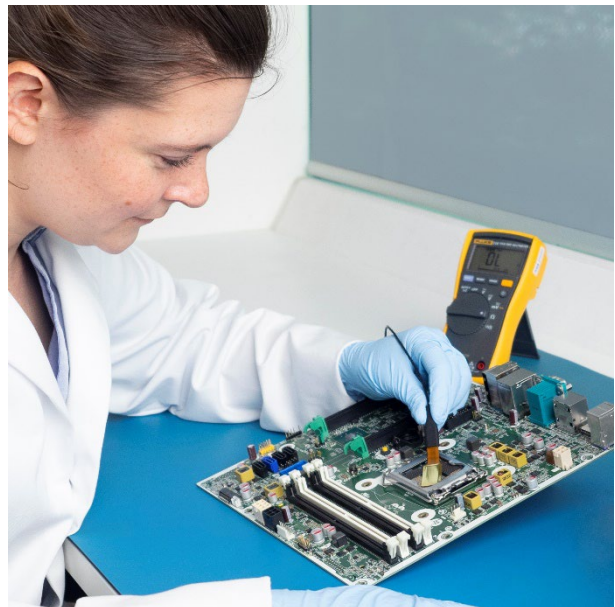


Figure 8 Model FHF05-15X30 with GLD-15X30 being installed to measure heat flux on a computer processor. The sensor is mounted on a well-prepared flat surface.

Suitable electronics

The combined measurement of heat flux and temperature offers a full picture of the thermal behaviour of a system. Heat flux sensors have a small millivolt signal output and are often combined with thermocouples as part of a larger test- or measuring system. We have several preferred solutions for amplification, data logging and data visualisation. See our application notes on [sensor amplification](#) or [FHF sensors with Hioki dataloggers](#).

Select your model

FHF05 is available in 5 different sizes. The following text helps you to select the right sensor for your application and electronics. Selecting the right electronics - sensor combination helps reducing total system costs.

Step 1

Visit the Hukseflux [YouTube](#) channel:

- [quick intro to heat flux](#) (3 min);
- [online course](#) (40 min);
- [separating radiation and convection](#) (2 min).

Step 2

Verify that FHF05 series is suitable for your situation/heat flux problem/application:

- the heat flux is between -10 to $+10 \times 10^3$ W/m²;
- the rated temperature range is below 120 °C;
- verify other specifications in the [manual](#).

Step 3

Verify what sizes may be used:

- define a maximum sensor size;
- see which model fits.

Step 4

- check if you want to separate radiation and convection;
- estimate the output range of the heat flux sensor(s) in [$\times 10^{-6}$ V] using the sensitivities in the specifications table: microvolt output range = heat flux range in [W/m²] x sensitivity in [$\times 10^{-6}$ V/(W/m²)].

Step 5

Verify that your electronics are suitable:

- your electronics accept analogue voltage differential input;
- the microvolt voltage measurement accuracy of your instruments is better than 1 % of the output range, to ensure it is not the limiting factor in measurement accuracy. If your electronics accuracy is insufficient, you may choose a larger sensor or put sensors in series to create a higher sensitivity;
- your electronics accepts type T thermocouples. If not, consider whether a temperature measurement is needed or if a separate temperature sensor can be added.

Step 6

In case of doubt, ask Hukseflux for assistance:

- ask for our input / suggestions. Send all information and specifications of your application to Hukseflux. This includes: purpose of the measurement, heat flux source, expected heat flux and temperatures, electronic devices used, sketch of the setup indicating specifications and dimensions;
- we can supply many different sensor models suitable for a wide range of applications.

See also

- [FHF05SC series](#) for a self-calibrating version of FHF05-50X50 or -85X85
- model [HFP01](#) for increased sensitivity (also consider putting two or more FHF05 sensors in series)
- [HTR02 series heater](#), for calibration and verification of performance of FHF-type sensors
- [BLK - GLD sticker series](#) to separate radiative and convective heat fluxes
- Hukseflux offers a complete variety of [heat flux sensors](#) with the highest quality for any budget

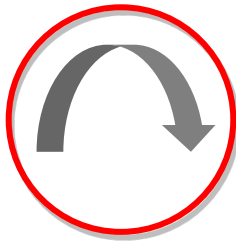
About Hukseflux

Hukseflux is the leading expert in measurement of energy transfer. We design and manufacture sensors and measuring systems that support the energy transition. We are market leaders in solar radiation- and heat flux measurement. Customers are served through the main office in the Netherlands, and locally owned representations in the USA, Brazil, India, China, Southeast Asia and Japan.

Interested in this product?
E-mail us at: info@hukseflux.com

FHF05 series outperforms competing models: how?

FHF05 series are Hukseflux' standard models for thin, flexible and versatile heat flux sensors.



Flexible

FHF05 series is extremely flexible and may be bent to a radius of 7.5 mm.

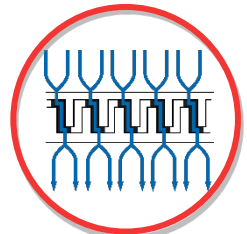
Large area

Larger is better: FHF05 85X85's sensitive area of 70 x 70 mm offers good averaging, leading to increased sensitivity. FHF05 series have a thermal guard around the sensitive area. The guard can also be used for mounting the sensor without disturbing the sensitive area.

Sensitive area with thermal spreaders reducing thermal conductivity dependence

Sensitivity independent of environment because of thermal spreaders

Unlike many competing sensors, FHF05 series sensors have thermal spreaders, i.e., conductive layers covering the sensor. These layers help reduce the thermal conductivity dependence of the measurement. By employing spreaders, the sensitivity of FHF05 series becomes independent of its environment.



Corrosion-proof plastic cover protecting the thermal spreader

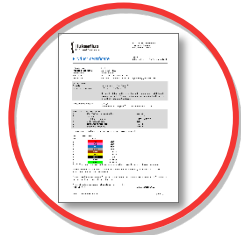
Thermocouple type T included

Durable waterproof wires with potted connection block, may be used as strain relief, temperature resistant up to 120 °C

BLK and GLD stickers series matching FHF05 series to measure radiative and convective heat flux separately

Best paperwork

Hukseflux has the paperwork covered; all FHF05 series sensors are provided with formally traceable calibration certificates. We calibrate in accordance with ASTM. C1130 - 21.



Stable: waterproof (IP67), corrosion-proof

FHF05 series sensor connection is potted, and waterproof. Its protection class is IP67. Competing sensors often have wire connections with open contact to the environment. This is a large potential source of damage, as well as a starting point for measurement errors, corrosion, and sensor instability.

5 sizes, covering most heat flux applications. Larger dimensions mean a higher sensitivity and a larger area over which the heat flux is averaged

FHF05-50X50

